2/

R E P O R T R E S U M E S

ED 010 403 08

EVALUATING THE EFFICIENCY AND EFFECTIVENESS OF SELF-INSTRUCTIONAL METHODS FOR SELECTED AREAS OF VOCATIONAL EDUCATION--PROGRESS REPORT.

BY- COFFEY, JOHN L.
BATTELLE MEMORIAL INST., COLUMBUS LABS., OHIO

REPORT NUMBER BR-5-1383 PUB DATE 30 NOV 66
REPORT NUMBER ERD-539
GRANT OEG-3-6-000539-1215
EDRS PRICE MF-$0.18 HC-$2.96 74P.

DESCRIPTORS- *VOCATIONAL EDUCATION, *JOB SKILLS, JOB ANALYSIS, OCCUPATIONAL INFORMATION, *IDENTIFICATION, *AUTOINSTRUCTIONAL METHODS, COLUMBUS, OHIO

A METHOD FOR IDENTIFYING VOCATIONAL SKILLS REQUIRED FOR MACHINE TRADES WAS REPORTED. STANDARDIZED PROCEDURES FOR IDENTIFYING SKILLS AND FOR ANALYZING VOCATIONAL CONTENT INFORMATION WERE DEVELOPED FOR APPLICATION TO AREAS OF VOCATIONAL EDUCATION. PROCEDURAL DEVELOPMENTS INCLUDED (1) SKILLS DEFINITION AND SCOPE, (2) A LITERATURE SEARCH, (3) METHOD DEVELOPMENT, (4) METHOD APPLICATION, AND (5) CONFERENCES, WORKSHOPS, AND INTERVIEWS WITH VOCATIONAL EDUCATORS. A FLOW CHART WITH VOCATIONAL SKILL DESCRIPTIONS, CONTENT INFORMATION, AND MEASURING INSTRUMENTS WAS INCLUDED IN THE REPORT. (GC)

ED010403

E-163 ED 5[illegible]

EVALUATING THE EFFICIENCY AND EFFECTIVENESS OF SELF-INSTRUCTIONAL METHODS FOR SELECTED AREAS OF VOCATIONAL EDUCATION

FIRST PROGRESS REPORT

SUMMARY OF TECHNICAL PROGRESS REPORT

for

EVALUATING THE EFFICIENCY AND EFFECTIVENESS OF SELF-INSTRUCTIONAL METHODS FOR SELECTED AREAS OF VOCATIONAL EDUCATION

GRANT NUMBER: OEG-3-6-000539-1215

This reporting period was devoted in part to the development of a method for identifying vocational skills. This method has been developed.

The criteria this method had to meet were: (1) identification of vocational skills which were consistent with a general skill definition developed as part of this program, (2) identification of vocational skills which represent behavioral units which are neither too general nor too specific in terms of the practical requirements of the program, and (3) identification of vocational skills in a form useful for analysis of vocational content material such as textbooks, course outlines, student manuals, etc.

Twenty-four vocational skills have been identified. Most of these were identified as a result of studying the machine-trades area, although some were identified by examining other vocational areas.

The machine-trades area has been analyzed to provide basic content information in relation to skills that are relevant to that area. Some of the 24 skills were identified as an additional output of this analysis.

Standardized procedures for identifying skills and for analyzing vocational content information have been developed. These procedures are now ready for application to additional vocational areas.

U. S. DEPARTMENT OF [illegible] EDUCATION AND WELFARE

This [illegible] received from the person [illegible] opinions stated [illegible] position [illegible].

PROGRESS REPORT

on

EVALUATING THE EFFICIENCY AND EFFECTIVENESS OF SELF-INSTRUCTIONAL METHODS FOR SELECTED AREAS OF VOCATIONAL EDUCATION

to

EDUCATIONAL RESOURCES DEVELOPMENT BRANCH
BUREAU OF RESEARCH
U.S. OFFICE OF EDUCATION

from

BATTELLE MEMORIAL INSTITUTE
Columbus Laboratories

S-1363 ERD-537

Grant Number: OEG-3-6-000539-1215

November 30, 1966

John L. Coffey
Principal Investigator

J. W. HOLCOMB
CONTRACTING OFFICER

INTRODUCTION

This is the first Progress Report on Grant Number: OEG-3-6-000539-1215 titled "Evaluating the Efficiency and Effectiveness of Self-Instructional Methods for Selected Areas of Vocational Education". The time period covered by this report is from July 1, 1966, through November 30, 1966.

The remainder of this report is organized into three major sections: (1) work completed, (2) plans for next reporting period, and (3) unanticipated problems. These three sections are presented below.

WORK COMPLETED

As the title implies, the overall objective of this program, as stated on page 8 of the proposal, is to evaluate the efficiency and effectiveness of self-instructional methods for selected areas of vocational education. On pages 8 and 9 of the proposal, eight specific types of activities are stated which will permit accomplishment of the overall objective. The work of this reporting period has been of the first two types of these specific activities: (1) analyzing selected areas of vocational education to identify primary vocational skills, and (2) from the primary skills identified, selecting those to which self-instructional methods will be applied.

These two activities form the foundation for the total program; therefore, their importance cannot be minimized. The reason for their importance is that the remainder of this program will utilize these skills

as the basis for evaluating the efficiency and effectiveness of self-instructional methods for selected areas of vocational education. In other words, the vocational content material to which self-instructional methods will be applied will be primary vocational skills.

It is of utmost importance to this program that vocational skills which are meaningful, practical, and useful be identified and selected. Therefore, during this reporting period, considerable time and care were expended to arrive at a method for identifying vocational skills that would meet these requirements. Once vocational skills are identified, the process of selecting those which are primary according to the criteria discussed on pages 16, 17, and 18 of the proposal will not represent a major task. A description of the tasks conducted to arrive at this method are described below.

Skill Definition and Scope

Traditionally, the learned behaviors exhibited in vocational trades have been called skills because of the relative predominance of perceptual-motor performance. In these trades, a distinction has been made between skill learning on the one hand and verbal or cognitive learning on the other. However, Fitts (1964) has pointed out that "The theoretical framework within which skilled performance is now being viewed by most students of this topic is such that sharp distinctions between verbal and motor processes, or between cognitive and motor processes serve no useful purpose. Since the processes which underlie skilled perceptual-motor performance are very similar to those which underlie language behavior, as

well as those which are involved in problem solving, and concept formation, we should expect to find that the laws of learning are also similar, and that no advantage would result from treating motor and verbal learning as separate topics".*

The first task that was conducted included determining precisely the nature of a vocational skill in view of the overall objective of this program. In this formulation, the term skill was viewed as meaning a comprehensive, meaningful (in terms of the behavior and in terms of vocational education) behavioral unit consisting of a logical starting point, developmental stages, and an end point evidenced by the generation of an end product. A skill was viewed as consisting of behavioral components. The completion of a simple discrimination task, memorization of a fact, or performance of a motor response were not viewed as skills; but as behavioral components constituting skills.

Therefore, for purposes of this program a general definition of a skill was formulated: a skill is a comprehensive, meaningful behavioral unit consisting of a starting point, developmental stages, and an end point and is composed of behavioral components encompassing cognitive, verbal, and motor processes.

After the general definition of a skill was formulated, the necessity for providing a guideline which would define the scope of behaviors to be classified as skills became clear. It was realized that providing a

*Fitts, Paul M., "Perceptual-Motor Skill Learning", in Categories of Human Learning, Arthur E. Melton (Ed.), Academic Press, 1964, pp 243-285.

scope (or size) definition which would equate skills in an absolute sense would be impossible. For example, whether one skill is somewhat more, or less, complex than another probably is not only impossible to determine, but of no practical concern for this program.

However, of practical concern was the necessity for providing some guideline which would preclude skills from becoming such large behavioral units that these units become specific to a single vocational area, or from becoming so small that their generality across vocational areas is assured. A number of attempts to provide a firm guideline were made. In all cases it appeared that the scope of behavior constituting a skill depended primarily upon examination of vocational content material. That is, in the context of vocational education for a particular area, it was possible to identify behaviors consistent with the general definition of a vocational skill and these behaviors were roughly comparable with respect to scope. Therefore, the content material itself was used as the primary determinant of the scope of a behavioral unit that was to be labelled a skill. It was found that given the definition of a vocational skill and a content source, vocational skills which were roughly comparable with respect to scope could be identified. This point is treated in greater length later in this report.

Literature Search

Concurrent with formulating the skill definition and scope, a literature search was conducted to determine whether or not existing methods

for identifying skills might be appropriate for this program. It also was of interest to determine if any of these methods provided more objective bases for skill identification than the method being generated by the project staff.

Several guidelines, implied in the concurrent work by the project staff on skill definition and scope, were formulated to assist in evaluating the methods uncovered by the literature search. First, any existing method had to permit identification of behavioral units consistent with the general definition of a skill that had been formulated. This was necessary because the definition is directly related to the ultimate accomplishment of the overall objective of this program. (For example, skills must be viewed as behavioral units for application of self-instructional methods. Second, they must be meaningful in terms of vocational education, etc.) A second guideline was that any existing method must provide behavioral scope definition consistent with skills as they exist in vocational education. (For example, a method which identifies a skill and a half in relation to vocational education would not be useful. Nor would a method be useful which, at its lowest level of specificity, identifies ten vocational skills as a single behavioral unit. Finally, a method which identifies one-tenth of a vocational skill at its lowest level of specificity likewise would not be useful.) A third guideline was that any existing method had to identify skills which were in a form to permit analysis of vocational content material such as textbooks, course outlines, student manuals, etc., in a reasonable time

and at the level of specificity required to generate effective teaching strategies and self-instructional materials.

The most complete taxonomic system of cognitive processes uncovered is that developed by Bloom, et al (1956) for the classification of educational goals.* The system contains six major classes: knowledge, comprehension, application, analysis, synthesis, and evaluation. The classes are further broken down into subclasses. The first class, knowledge, involves memorization, i.e., information storage and retrieval. The remaining five classes are described by the authors as intellectual abilities and skills, i.e., "organized modes of operation and generalized techniques for dealing with materials and problems". It was noted that the major classes form a hierarchy in which the behaviors in one class are built on and dependent upon the behaviors of a preceding class. Therefore, the behaviors of a class do not form a meaningful behavioral unit as defined previously. Rather, the classes in this system appear to be comparable to the behavioral components stated in the general skill definition. A further shortcoming of this system is the degree of specificity required in utilizing it for analyzing vocational information. That is, the use of this system in analyzing a vocational textbook would result, essentially, in the generation of another textbook. For these reasons, it was determined that this taxonomic system was not appropriate for the purposes of this study.

*Bloom, Benjamin S., (Ed.) Taxonomy of Educational Objectives, David McKay Company, Inc., 1956.

Another taxonomic system uncovered by the literature search is that discussed by Melton (1964) which consists of the traditional labels employed to categorize learning experimentation.* This system also consists of six classes: conditioning, rote learning, probability learning, skilled learning, concept learning, and problem solving. This system also is hierarchical in nature in that higher classes incorporate lower classes, and, therefore, is not consistent with the general definition of a skill formulated for this program. Furthermore, in contrast to the Bloom, et al, system, this system defines skills at such a general level that they would be useless for purposes of this study; the information that they would generate would not be specific enough to permit the development of effective teaching strategies and self-instructional materials. A similar system is that devised by Gagné which consists of six classes: response learning, chaining of responses, verbal learning, concept formation, principle learning, and problem solving.** This system contains the same shortcomings as Melton's.

Other pertinent procedures were uncovered which fell into two general categories: (1) those employing some form of task analysis (as utilized by industrial and military training personnel for the preparation of training materials), and (2) those employing statistical techniques for clustering or grouping jobs on the basis of some scale of similarity. The

*Melton, Arthur E., "The Taxonomy of Human Learning: Overview", in Categories of Human Learning, Arthur E. Melton (Ed.), Academic Press, 1964, pp 325-339.

**Gagné, from a Seminar on Transfer of Training presented by Dr. Reed Lawson, September, 1964, at Battelle Memorial Institute, Columbus, Ohio.

procedure described by Miller (1953) in which the details of a method for man-machine task analysis is presented is characteristic of the former category.* A subsequent refinement of this procedure for the analysis and specification of behavior for training, also by Miller, is presented in Glaser, et al (1962).** Task analysis is an excellent procedure for collecting very detailed information, and for specifying all aspects of the tasks performed on a job required by the training specialist for the design of training materials. For the purposes of this study, however, task analysis is inappropriate, because it is too specific. Furthermore, task analysis does not provide a means for making comparisons among vocational areas with regard to commonality and differences in the skills required. Finally, the unit of analysis in task analysis, the task, is not a comprehensive, meaningful behavioral unit; it is comparable to the behavioral components comprising a skill. Task analysis was, therefore, rejected as an appropriate procedure for this study.

The studies of Palmer and McCormick (1961),*** and Orr (1960),**** are representative of the application of statistical methods for clustering

*Miller, Robert B., A Method for Man-Machine Task Analysis, Wright Air Development Center, June, 1953.

**Miller, Robert B., "Analysis and Specification of Behavior for Training", in Training Research and Education, Robert Glaser (Ed.), University of Pittsburgh Press, 1962, pp 31-62.

***Palmer, Jr., George J. and McCormick, Ernest J., "A Factor Analysis of Job Activities", in Journal of Applied Psychology, Vol. 45, No. 5, October, 1961, pp 289-294.

****Orr, D. B., "A New Method for Clustering Jobs", in Journal of Applied Psychology, Vol. 44, No. 1, February, 1960, pp 44-49.

jobs on the basis of scale measures of similarity. In the former study, the scale used was a job-activities checklist which consisted of 177 items describing job activities in terms of worker behaviors. A large sample of jobs were analyzed by reading the written job description for each job, and then indicating on the checklist the presence or degree of each job activity which was considered to be pertinent to the job in question. The checklist data for the sample jobs were correlated and subjected to factor analysis. The latter study, by Orr, utilized a scale yielding a rating of how much of each of nine aptitudes, as measured by the United States Employment Service General Aptitude Test Battery, was required for satisfactory performance on the sample of jobs studied. Specially trained raters used detailed jobs descriptions of the sample of jobs as their raw data. A "D" measure, the distance between two points in a plane, was computed from the ratings and a clustering technique was applied to these measures.

The worker behaviors described in the job-activities checklist used in the Palmer and McCormick study were comparable to those described in task analysis, and were too specific to be appropriate for this program. The results of the factor analyses were of interest, but described behavior at a level which was too general to be of use. The possible use of factor analysis in the present study was considered and dropped only after an appropriate method of application could not be devised. The procedure used by Orr for clustering jobs on the basis of aptitude similarity would yield

information too general to permit the generation of effective teaching strategies and self-instructional materials. Furthermore, the aptitude dimensions were not consistent with the general definition of a skill. The use of the "D" measure and clustering technique for the analysis of vocational training information was considered, but subsequently dropped because of the estimated time required to perform such an analysis.

Based upon the guidelines stated earlier, the literature search did not uncover a satisfactory system or method for identifying vocational skills. Therefore, consistent with the proposal, a developmental approach was taken to the task of providing a method which would yield vocational skills appropriate for accomplishing the objective of this program.

Method Development

The method development was begun in connection with the machine-trades area. By examining selected portions of content material, subject-matter descriptions were obtained. These descriptions approximated behaviors that, according to the general skill definition, could be classified as vocational skills. Although the subject-matter descriptions were not in a final form, they did represent a useful, initial approximation to vocational skills.

To provide a more uniform basis for evaluating the initial descriptions, these descriptions were translated into descriptions of behavior (rather than subject matter). The behavioral descriptions then

were reviewed by the project staff in relation to the general skill definition for the purpose of screening out any descriptions which obviously did not meet the conditions set forth in the definition. Those descriptions which appeared to be consistent with the general skill definition were next reviewed by the vocational consultant as a further screening step.

The behavioral descriptions surviving the screening procedures were given a skill name which meaningfully described the behavior. The next step was to analyze each behavioral description into its constituent behaviors. This was done by further studying content material and by obtaining inputs from the vocational consultant. After the constituent behaviors had been identified, they were sequenced according to information obtained from content material and the vocational consultant. Each skill was checked against every other skill to detect any inconsistencies or overlap. Where either was found, the skill was redefined and reanalyzed for constituent behaviors.

At this point, a limited set of vocational skills had been formulated with each skill consisting of a general behavioral description and sequenced constituent behaviors. The next step was to assess the degree of usefulness of this skill form for analyzing vocational material in order to obtain content information relating to each constituent behavior within the skill. This type of information is mandatory for the development of teaching strategies and self-instructional materials.

Upon initial application of the vocational skills to content material, a problem was immediately encountered. This problem was uncertainty about the form in which content information relevant to each constituent behavior should be recorded. The skill descriptions and the constituent behaviors alone were not sufficient to overcome this problem. Therefore, an example, suggesting the recording form for information, was developed for each constituent behavior. This technique was designed to provide guidance and standardization for recording information.

The next procedure attempted was to take a single skill containing the example form for recording information and to apply it serially to an entire machine trades textbook by recording information relevant to each constituent behavior and marking off those sections of the textbook so analyzed. Then, a second skill was applied in the same fashion. This procedure for analyzing content material was formalized by developing a flow chart describing each procedural step.

It was found that as the analyst became familiar with the content material, the "one-skill-at-a-time" procedure was inefficient. A more efficient one was for the analyst to go through the textbook a page at a time recording information relevant to any one of the constituent behaviors of any skill. This procedure also was portrayed as a flow chart.

With periodic minor improvements, the method developed was found to be quite efficient and yielded vocational skills having several

characteristics. First, the skills identified were roughly comparable with respect to scope. Second, the skills were useful for analysis of a number of types of vocational content material including inputs provided by vocational experts. Third, the method identified skills that were practical for vocational education, and meaningful to vocational experts in the field.

Four outputs resulted from the method-developmental work. A first was two flow charts detailing the procedure for applying the vocational skill descriptions to vocational content information. These two flow charts are included as Appendix A. A second output was the vocational skill descriptions, each including a skill name, a general behavioral description, and a list of constituent behaviors. These descriptions, most of which were obtained from the machine-trades area, are included as Appendix B. A third output was an example suggesting the form for recording content information. This example for the vocational skill of "measuring" is included as Appendix C.

The fourth output was an eight-step procedure for identifying vocational skills. This procedure is summarized below.

Step 1 - Obtain initial vocational skill description from content source using general skill definition

Step 2 - If necessary, translate vocational skill description into a behavioral description

Step 3 - Compare behavioral description with general skill definition as a screening check

Step 4 - Determine and apply a meaningful name to the skill

Step 5 - Analyze the behavioral description into constituent behaviors

Step 6 - Sequence the constituent behaviors

Step 7 - Compare behavioral description and constituent behaviors with other vocational skills and resolve any inconsistencies or overlap

Step 8 - Develop examples illustrating recording form for content information relevant to each constituent behavior.

Application of Method

The machine-trades area has been analyzed using most of the vocational skills included as Appendix B. During the analysis, additional skills were identified and included in the analysis. These also are included in the skills shown as Appendix B.

Besides identifying additional skills and providing relevant content information for all skills relevant to machine trades, the analysis also served to standardize procedures for analysis. These procedures will be of great value for making future analyses more routine than developmental.

The result of the analysis of the machine-trades curriculum has provided specific information about each constituent behavioral component

of each vocational skill. As an example, the result of the analysis for the skill of "measuring" is included as Appendix D.

Involvement of Vocational Educators

To assure that the vocational skills and their associated content information represent outputs that are meaningful, practical, and useful, a vocational educator from each of the trade and industrial areas has been secured as a Battelle consultant. In each case, the vocational educator was recommended by the State Supervisor (Ohio) of Trade and Industrial Education as being outstanding in his field. These educators are located throughout Ohio.

On November 19, 1966, a meeting of these vocational educators and the Battelle project staff was held at Battelle. The purpose of this meeting was to orient the vocational educators with regard to this program and to outline the nature of the inputs needed from them. At this time, these inputs are viewed as checking the accuracy of the output of the analyses, providing additional content information should it not be obtainable from other sources, making recommendations as to how specific parts of the program output could be made more meaningful, practical, and useful for vocational education, and checking the self-instructional materials for accuracy of content information. Each vocational educator will be employed primarily in relation to his vocational speciality (machine trades,

auto mechanics, drafting, cosmetology, electrical-electronics, and sheetmetal and welding) as he is needed.*

Miscellaneous

Also during this reporting period, a number of specific inquiries about the program have been received and answered. In addition, on November 15, 1966, Battelle was visited by representatives of the Appalachia Educational Laboratory, Inc., to discuss this program and their program and to explore problems and areas of mutual interest.

A Battelle staff member participated in the Conference on Instructional Methods and Teacher Behavior held by the Far West Laboratory for Educational Research and Development. This participation included a presentation describing this program. Expenses for Battelle's participation in this conference were paid by the Far West Laboratory for Educational Research and Development.

PLANS FOR NEXT REPORTING PERIOD

A number of tasks, most of which will be conducted simultaneously, are planned for the next reporting period. Each of these tasks is part of one of the eight specific activities stated on pages 8 and 9 of the proposal under the objective of the program. Each task and the specific activity of which it is part are described below.

---

*Eight vocational educators have been secured as consultants. Eight are required rather than six because electrical-electronics and sheetmetal and welding are being viewed as four areas rather than two.

Primary Vocational Skill Identification and Selection

The first task planned for the next reporting period is continuing the identification of vocational skills, continuing the content analysis, and selecting primary vocational skills. This is part of the first two activities listed on page 8 of the proposal: analyzing selected areas of vocational education to identify primary vocational skills, and from the primary vocational skills identified, selecting those to which self-instructional methods will be applied.

It is anticipated that the identification of vocational skills, the content analyses, and selection of primary vocational skills for the trade and industrial area (machine trades, auto mechanics, drafting, cosmetology, electrical-electronics, and sheetmetal and welding) will be completed within the first two months of the next reporting period. Inasmuch as procedures for the analysis of vocational content material have been standardized, this task can now move more rapidly. This is because more staff members, working with the standardized procedures, can work simultaneously, and more or less independently on this task.

Additionally, vocational skills for at least one other vocational area will be identified and selected. At this point in time, it is believed that this area will be distributive education.

Developing Self-Instructional Materials

A second task planned for the next reporting period is the development of self-instructional materials. This effort is part of the following three specific activities listed on page 8 of the proposal: selecting or generating strategies for teaching each selected primary vocational skill, selecting or generating self-instructional methods for teaching each selected primary vocational skill, and empirically developing self-instructional materials to teach each selected primary vocational skill.

It is anticipated that this procedure will be completed for at least two, and possibly as many as four, primary vocational skills which will be selected from the trade and industrial area. At this point in time, it is not possible to specify which vocational skills will be selected. However, it is probable that only a few, if any, additional vocational skills will be identified in the trade and industrial area. Therefore, it is highly likely that the skills selected will be selected from those already identified, and included in this report (Appendix B).

If no unforeseen problems are encountered, it also is planned to evaluate with vocational students the self-instructional materials prepared during the next reporting period. This work is part of a specific activity listed on page 8 of the proposal: evaluating the efficiency and effectiveness of the self-instructional materials for each selected skill. If this cannot

be accomplished during the next reporting period, it would be one of the first activities of the following reporting period.

Preparing a Monograph

A third task planned for the next reporting period is preparing a monograph covering selected aspects of the work that has been accomplished. This is part of a specific activity listed on page 9 of the proposal: disseminating information concerning self-instruction in vocational education.

It is anticipated that this monograph will deal in depth with the method for identifying vocational skills.

UNANTICIPATED PROBLEMS

Two unanticipated problems of significant enough proportions to be reported were encountered during this reporting period. Each is discussed separately below.

Vocational Skill Identification

The major problem encountered during this activity was that the development of the procedures for identifying vocational skills has been a somewhat different activity than originally anticipated. What is meant by this is explained below.

Originally, we had foreseen this activity as a substantial one, but as one which could involve a number of staff members, therefore reducing

the number of calendar months necessary for this task. It became apparent very early in the project, however, that it would be quite inefficient to bring a large number of staff members together to work on most aspects of this task. This was mainly because both technical capability of staff members and vocational content information were intricately involved in developing the method for identifying vocational skills. That is, developing the method moved more efficiently with a few staff members being substantially involved in all aspects of it, than by having a larger number of staff members participate by assigning different aspects of the task to different staff members. The latter procedure was attempted early in the program and considerable time had to be devoted to informing all staff members about what each of the other staff members was doing. This represented a major inefficiency.

Therefore, the decision was made to involve only a few staff members in this activity until standardized procedures were developed, and then to move to a more routine application of these procedures by a greater number of staff members. The report of expenditures reflects this decision in that expenditures per month were below those originally anticipated. We believe this decision was in the best overall interests of the program.

The Nature of Vocational Content Material

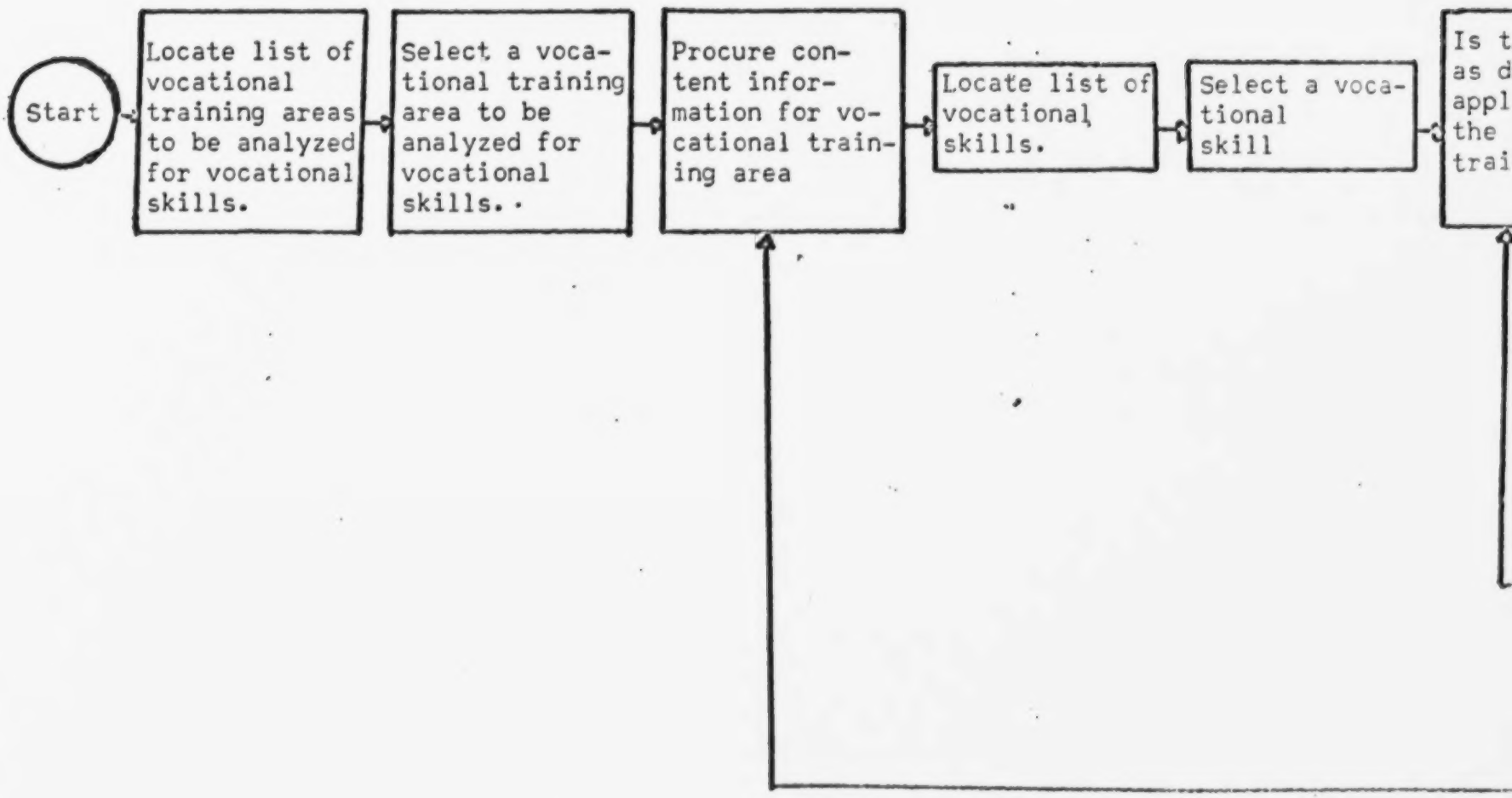
Another unanticipated problem was the extent to which vocational content information is subject-matter directed rather than behavior directed. In many instances, subject matter could be restructured into behavioral statements; however, in some instances it was necessary to obtain additional information from content experts.

Of course, many educational sources are subject-matter directed; this was anticipated. However, many of the vocational-education sources that were analyzed were quite extreme in this direction. These sources were recommended as the best available by Battelle's consultant in the trade and industrial area from the Center for Vocational and Technical Education.

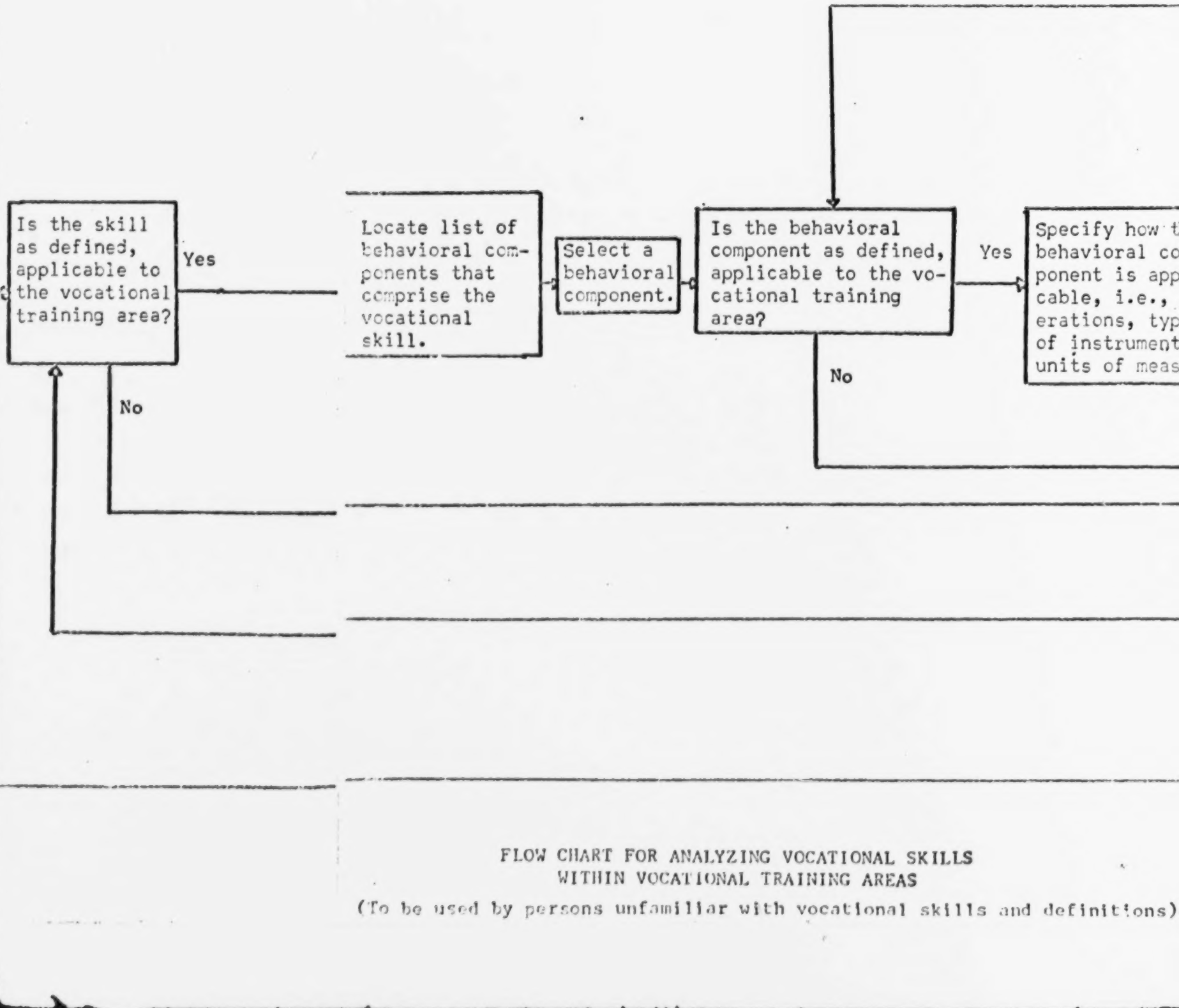
Unquestionably, this discrepancy will continue to be found in varying degrees. It has not represented an insurmountable obstacle, but this problem has reduced the speed of the analysis procedure by requiring us to find additional inputs to fill in behavioral "gaps" remaining after content material has been analyzed. Usually these inputs have been provided by vocational experts.

APPENDIX A

SECTION 1

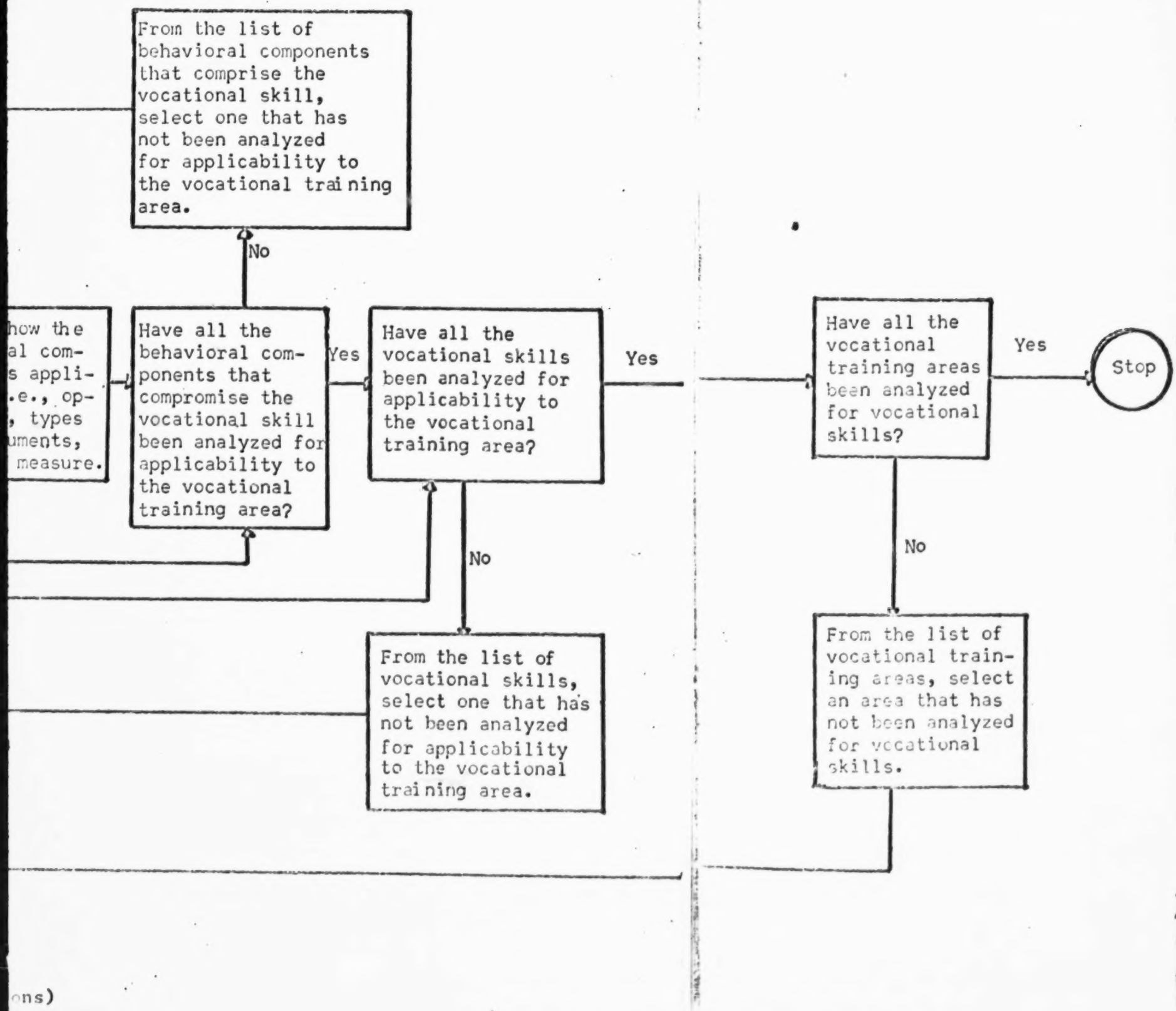

Start
Locate list of vocational training areas to be analyzed for vocational skills.
Select a vocational training area to be analyzed for vocational skills. .
Procure content information for vocational training area
Locate list of vocational skills.
Select a vocational skill
Is t
as d
appl
the
trai

SECTION 2

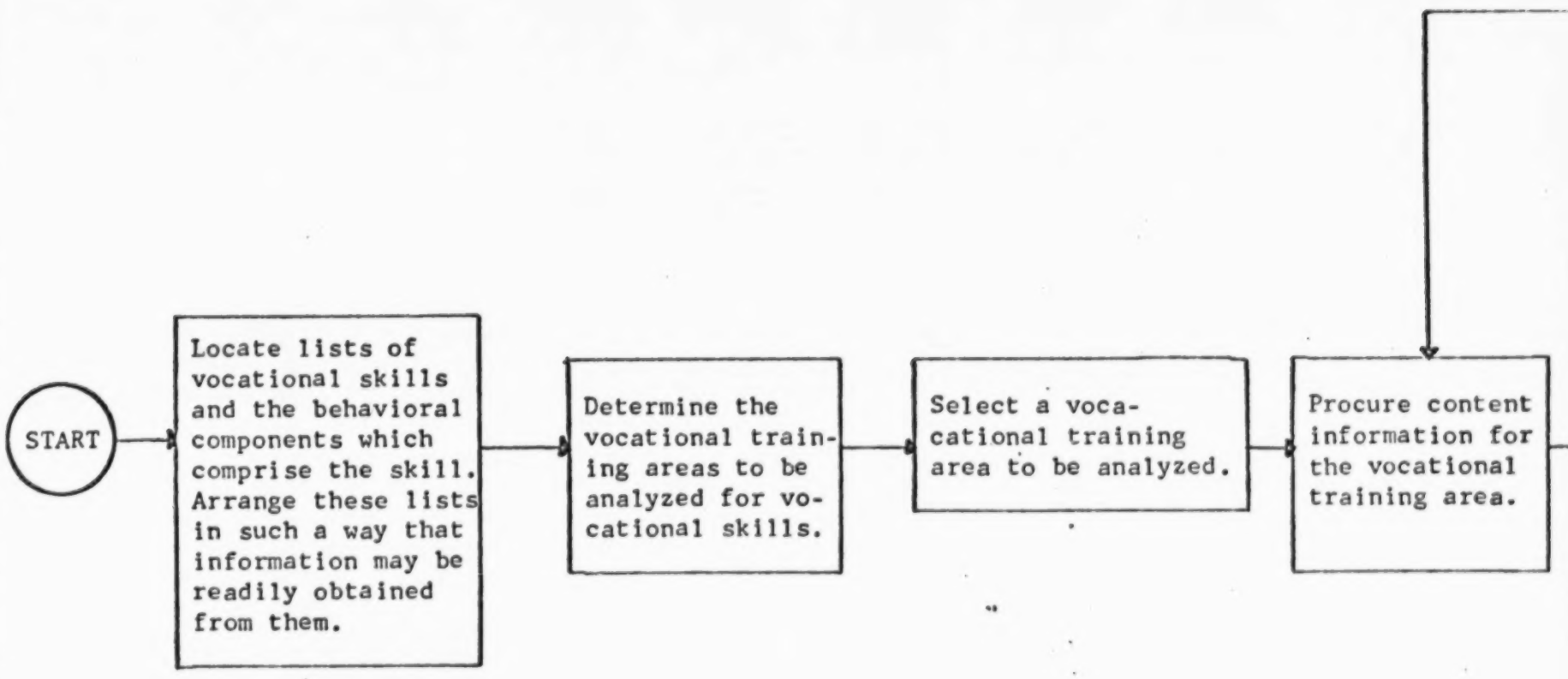


FLOW CHART FOR ANALYZING VOCATIONAL SKILLS
WITHIN VOCATIONAL TRAINING AREAS

(To be used by persons unfamiliar with vocational skills and definitions)

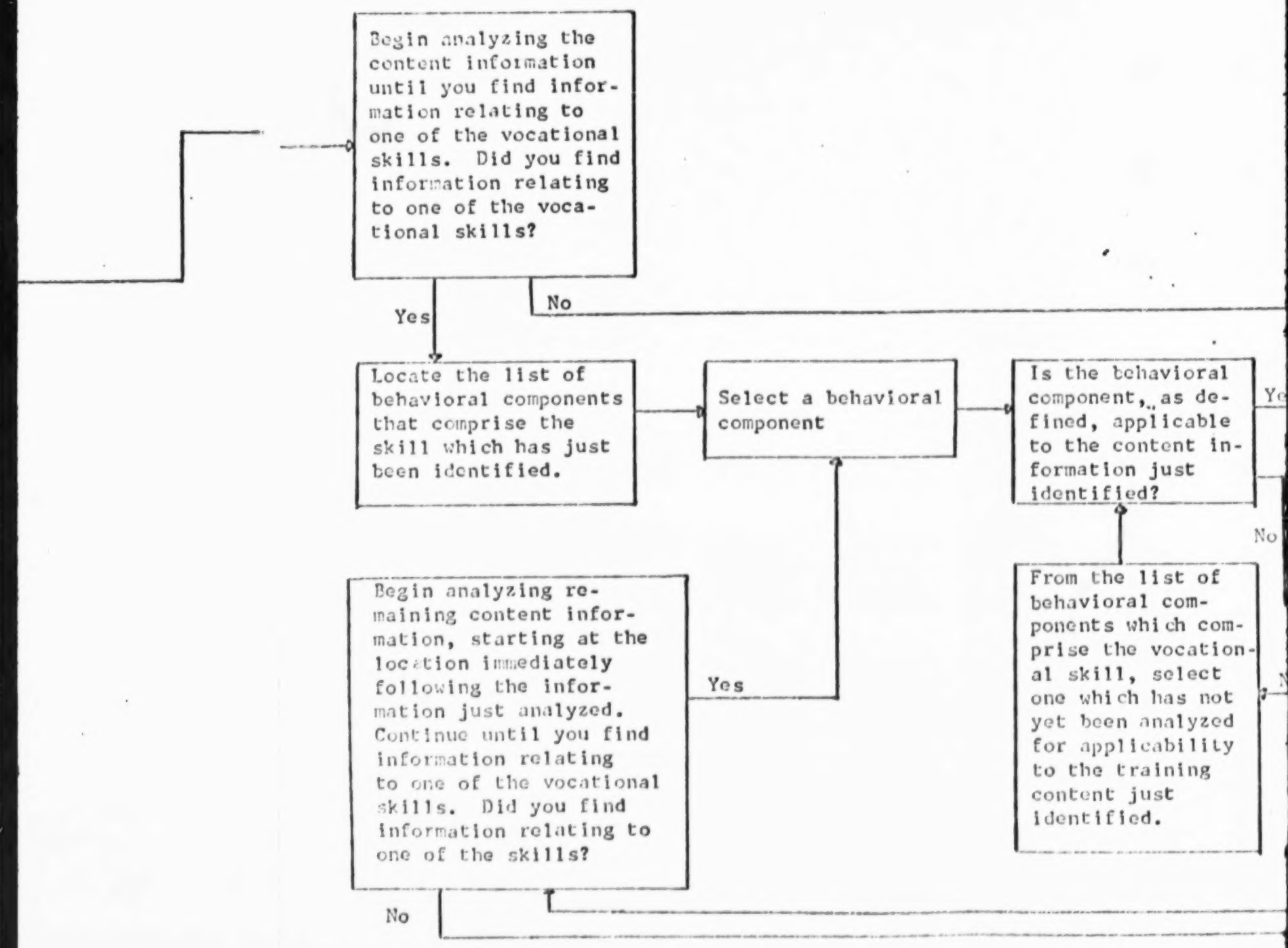

From the list of behavioral components that comprise the vocational skill, select one that has not been analyzed for applicability to the vocational training area.
No
how the
al com-
s appli-
.e., op-
, types
uments,
measure.
Have all the behavioral components that compromise the vocational skill been analyzed for applicability to the vocational training area?
Yes
Have all the vocational skills been analyzed for applicability to the vocational training area?
Yes
No
From the list of vocational skills, select one that has not been analyzed for applicability to the vocational training area.
Have all the vocational training areas been analyzed for vocational skills?
Yes
Stop
No
From the list of vocational training areas, select an area that has not been analyzed for vocational skills.

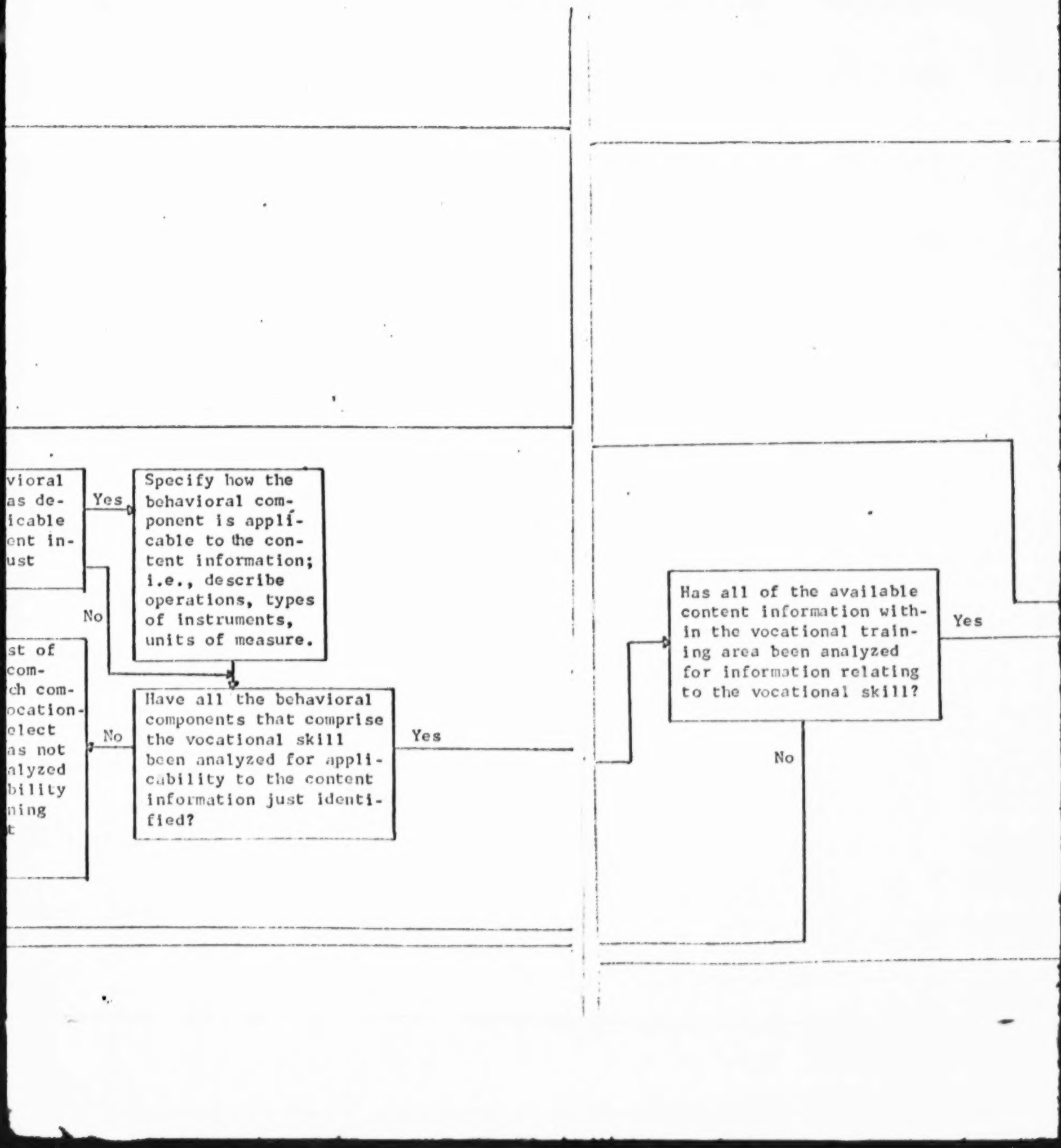
ons)


START
Locate lists of vocational skills and the behavioral components which comprise the skill. Arrange these lists in such a way that information may be readily obtained from them.
Determine the vocational training areas to be analyzed for vocational skills.
Select a vocational training area to be analyzed.
Procure content information for the vocational training area.

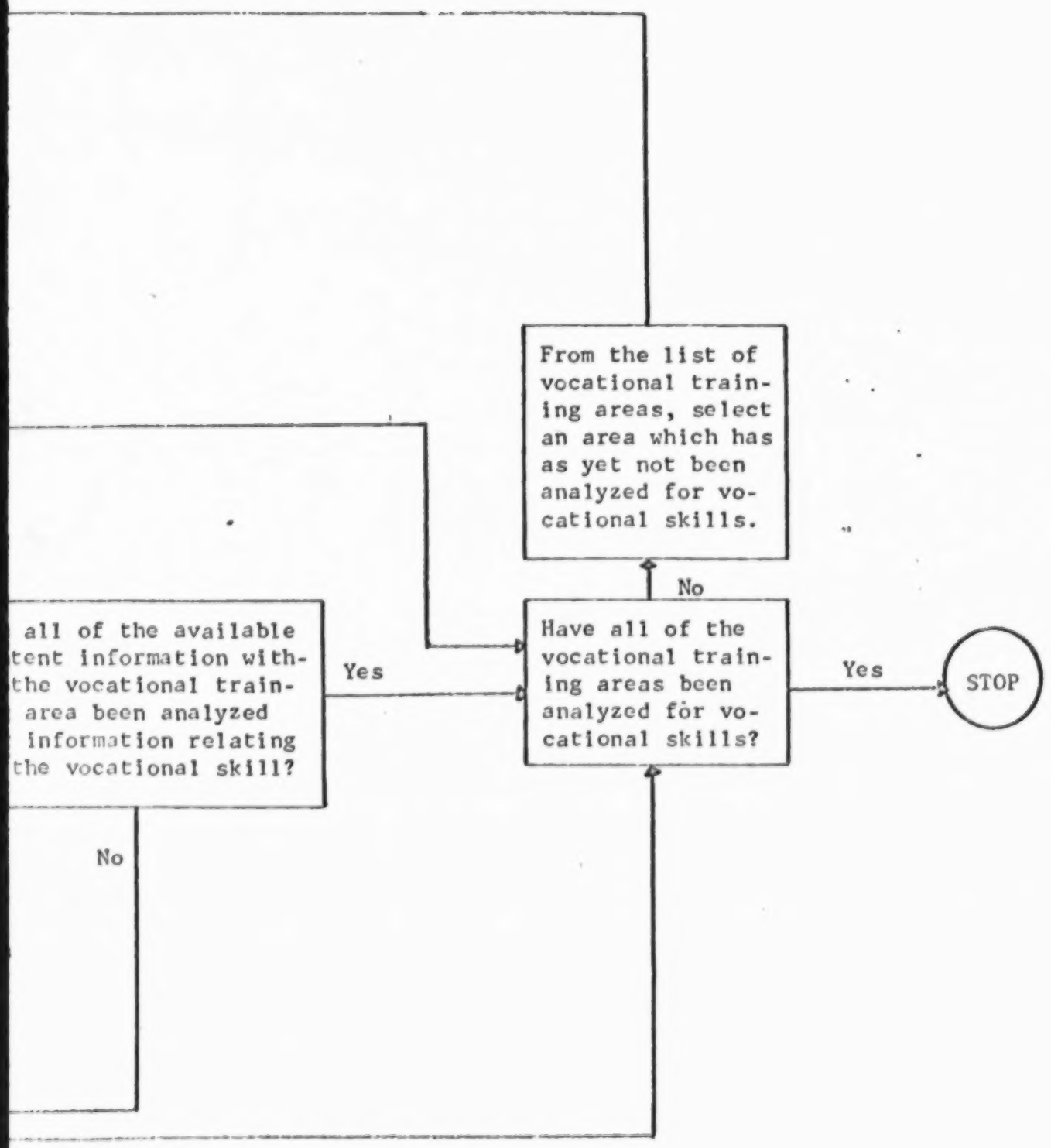
FLOW CHART FOR ANALYZING VOCATIONAL SKILLS
WITHIN VOCATIONAL TRAINING AREAS

(To be used by persons familiar with vocational skills and definitions.)


Begin analyzing the content information until you find information relating to one of the vocational skills. Did you find information relating to one of the vocational skills?
Yes
No
Locate the list of behavioral components that comprise the skill which has just been identified.
Select a behavioral component
Is the behavioral component, as defined, applicable to the content information just identified?
Ye
No
From the list of behavioral components which comprise the vocational skill, select one which has not yet been analyzed for applicability to the training content just identified.
Begin analyzing remaining content information, starting at the location immediately following the information just analyzed. Continue until you find information relating to one of the vocational skills. Did you find information relating to one of the skills?
Yes
No


vioral
as de-
icable
ent in-
ust
Yes
Specify how the behavioral component is applicable to the content information; i.e., describe operations, types of instruments, units of measure.
No
st of
com-
ch com-
ocation-
elect
as not
alyzed
bility
ning
t
No
Have all the behavioral components that comprise the vocational skill been analyzed for applicability to the content information just identified?
Yes
Has all of the available content information within the vocational training area been analyzed for information relating to the vocational skill?
Yes
No

SECTION 4


From the list of vocational training areas, select an area which has as yet not been analyzed for vocational skills.
No
Have all of the vocational training areas been analyzed for vocational skills?
Yes
STOP
Yes
all of the available tent information with- the vocational train- area been analyzed information relating the vocational skill?
No

APPENDIX B

APPENDIX B

Measuring

Uses the appropriate measuring instruments and units of measurement to determine the dimensions, quantity, degree, and/or capacity of work media.

1. Determines appropriate scale of measurement, unit of measurement, and level of precision.
2. Selects measuring instrument(s) possessing the appropriate scale of measurement, unit of measurement, and level of precision.
3. Operates measuring instrument(s).
4. Determines dimensions, quantity, degree, and/or capacity of work media.

Precision Adjustment

Detects deviations of actual values of work media from range of proper values and makes corrective changes by motor manipulation to bring actual values within range of proper values.

1. Compares present values or conditions of work media with proper values or conditions.
2. Determines if any adjustment is necessary.
3. Either makes an adjustment involving precise coordination of sensory cues and motor manipulation (return to measurement) or makes no adjustment.

Work Planning

Given specifications of an end product, determines the work operation(s) to be performed; the tools equipment, materials and work media required; and the sequence in which the operations(s) will be performed.

1. Selects work media based on product specifications, personal experience, and work media characteristics.
2. Using charts, technical manuals, and personal experience, plans work operations to be performed.
3. Determines the tools, equipment, and material required to perform the necessary operations.
4. Determines the time, place, and/or sequence of operations or actions to be taken based on an analysis of available data.

Work Set-up

Positions, adjusts, and secures tools, equipment, materials, and work media in proper relation to one another to begin performing work operations.

1. Moves work media to work area and positions and clamps pieces of work media together, when required.
2. Inserts, throws, dumps or places work media in machine or fixture.
3. Positionsand secures work media to holding device, machine table, chucks, centers, or fixtures.
4. Installs required tools on appropriate machines or equipment.
5. Postions and aligns toqls and work media in relation to each other to perform operations and positions model in parallel relationship to work media, if necessary.

Work Layout

Prepares the surfaces and/or composition of work media and lays out work surface, sometimes by marking, in preparation for work operations.

1. Checks work media for defects and takes corrective action, and removes impurities from work media.
2. Positions and secures work media to holding devices for layout, when necessary.
3. Prepares surfaces and/or composition of work media for the required work operations.
4. Marks and scribes dimensions and/or reference points such as curves, lines, holes, and other appropriate symbols on work media where operations are to be performed working to specified tolerances.

Hand Tool Operation

Applies appropriate hand tool to the work media with sufficient force, pressure, and control of motion to perform the desired operation, takes corrective action when tool is not functioning properly, and terminates operation when complete.

1. Assumes proper position of body and hands in order to produce appropriate stroke.
2. Applies appropriate hand tool to work media with sufficient force and pressure.
3. Applies appropriate hand tool to work media with sufficient control of motion.
4. Using the appropriate equipment, applies lubricant to work media or coolant against the tool.
5. Takes corrective action when the tool is not functioning properly.
6. Terminates operation with complete.
7. Removes processed work media from holding devices, when applicable.

Portable Power Tool Operation

Starts appropriate portable power tool, applies it to the work media with sufficient force and control of motion to perform the desired operation, takes corrective action when tool is not functioning properly and shuts off tool when operation is complete.

1. Moves controls to set specified speeds, where applicable.
2. Starts appropriate tool by operating the switch which activates the driving unit of the machine.
3. Applies tool to work media with sufficient force.
4. Applies tool to work media with sufficient control of motion.
5. Using the appropriate equipment, applies lubricant, when necessary.
6. Takes corrective action when tool is not functioning properly.
7. Shuts off tool when operation is complete.
8. Removes processed work media from holding devices, where applicable.

Stationary Power Tool Operation

Starts appropriate stationary power tool; sets speed, feed, and depth of cut; checks for errors in settings; takes corrective action when tool is not functioning properly; and shuts off tool when operation is complete.

1. Sets control to regulate speed and feed of machine.
2. Sets control to regulate depth of cut, where applicable.
3. Guides operating head manually through process by moving levers, handles or other controls, where applicable.
4. Starts appropriate tool by operating the switch which activates the driving unit of the machine.
5. Using the appropriate equipment, applies lubricant to work media or coolant against the tool.
6. Moves tool into contact or into close proximity of work media and engages automatic feed of machine.
7. Takes corrective action when machine is not functioning properly.
8. When operation is complete, removes operating head from work media by reversing movement of controls.
9. Shuts off machine when operation is complete.
10. Removes processed work media from bed of machine or fixture.

TOOL AND EQUIPMENT MAINTENANCE

Provides periodic cleaning, lubricating, checking, precision adjustment and/or mechanical trouble shooting, when necessary; and provides proper storage of tools and equipment to insure proper functioning.

1. Using the appropriate materials, cleans and lubricates tools and equipment.

2. Examines the tool or equipment for wear and determines the nature and the extent of malfunction, if any (may require disassembly and reassembly).

3. Performs a precision adjustment or performs mechanical trouble shooting, when necessary.

4. Provides proper storage for tools and equipment, where necessary.

Duplicating Machine Operation

Given a master copy of the material to be duplicated, inserts master copy in appropriate position, makes any necessary settings, begins operation of the machine, checks for errors in settings, takes corrective action when machine is not functioning properly, removes copies when operation is complete.

1. Periodically cleans the machine.
2. Places blank copy paper in feed tray and adjusts machine for the size of paper, if necessary.
3. Sets controls for number of copies, heaviness of print, and speed of machine.
4. Places master copy in appropriate position in the machine.
5. Turns on the machine and begins the operation.
6. Takes corrective action when machine is not functioning properly.
7. Removes copies when operation is complete and keeps a record of the number of copies made, or desired.

Business Machine Operation

Given basic business information, records information in appropriate format with a high degree of accuracy by manipulating control keys at a high rate of speed, takes corrective action when the machine is not functioning properly, and ejects or removes record when operation is complete.

1. Positions a plate, stencil, paper, tape, or a standard format in the machine, when necessary.
2. Manipulates control keys at a high rate of speed to record business information with a high degree of accuracy.
3. Takes corrective action when the machine is not functioning properly.
4. Checks the machine record and makes corrections, when necessary.
5. Ejects or removes record when the operation is complete.

Drawing and Sketching

Given a three dimensional concept or model of work media, constructs a three dimensional representation in a two-dimensional plane using pen, pencil, or other drawing instruments.

1. Determines the views of the work media to be presented in drawing by examing rough sketches or models.
2. Selects scale of dimensions for drawing(s) and determines radii and point locations.
3. Draws freehand sketches to clarify design detail and functional criteria.
4. Checks dimensions of parts in the sketches, checks relation of one part to another, and checks relation of various parts to whole structure, and makes any adjustments or changes necessary or desired.
5. Operates drawing instruments to prepare accurate final working plans and detailed drawings.
6. Uses knowledge of various machines, engineering practices, mathematics, and other physical sciences to complete drawings, when necessary.
7. Develops charts, graphs, and schematics to describe and illustrate system's operating characteristics and statistical data.

Mathematical Problem Solving

Given a task requiring a numerical solution, uses any combination of arithmetic, algebraic, geometric, and/or trigonometric processes of problem solving to obtain a solution.

1. Generates a statement of the problem in form of an equation, formula, etc.
2. Determines the sequence of operations required for problem solution.
3. Adds, subtracts, multiplies, and divides integers, common fractions, decimal fractions, algebraic expressions.
4. Finds the least common denominator of common fractions, and converts common and improper fractions to decimal fractions, and decimal fractions to common fractions and improper fractions, when necessary.
5. Calculates percentages, interest, averages, ratios, proportions, and square roots, when necessary.
6. Calculates areas or volumes of objects, when necessary.
7. Uses tables of logarithms and trigonometric functions, speeds and feeds, etc., when necessary.
8. Uses algebraic processes to obtain a solution, when necessary.
9. Uses geometric processes to obtain a solution, when necessary.
10. Uses trigonometric processes to obtain a solution, when necessary.

Symbol Manipulation

Correctly names an object and/or its characteristics, a process, or a concept; identifies either the characteristics of an object or a process being carried out; produces the correct symbol to represent an object, the characteristics of an object or a concept; correctly applies or demonstrates the concept.

1. Given an object, the characteristics of an object, the observation of a process or a process description, a concept (e.g., numerals, center line, etc.) or symbols, correctly names the objects, the characteristics of an object, the process or the concept.
2. Given the name of an object or process, identifies either the object and/or its characteristics or the process being carried out.
3. Given an object, the characteristics of an object or a concept, produces the correct symbol which represents the object, characteristics of the object, or the concept.
4. Given the name of a concept, correctly applies or demonstrates the concept.

Written Business Communication

Using appropriate grammar and terminology, constructs a verbal composition which effectively conveys the desired information.

1. Determines what information is needed.
2. Acquires and verifies the information to be contained in the communication.
3. Organizes information in a logical efficient sequence.
4. Writes reports, letters, and other correspondence using clear and concise language and appropriate terminology, grammar, and format.
5. Corrects and revises previously written material.
6. Numbers illustrations, tables, and appendices and gives credit to reference sources, when necessary.

Use of Business Forms

Selects appropriate standard format to record transactions, administers, or fills-in the form and files and/or distributes the forms.

1. Compiles the information requested or required.
2. Selects appropriate standard format to record transactions.
3. Administers or fills-in the forms using clear and concise language and appropriate terminology and grammar.
4. Files and/or distributes the forms.

Customer Interaction

Uses oral communication, facial expression and gestures in face-to-face customer interactions to effect a favorable attitude toward you, which the customer may or may not evidence.

1. Uses commonly accepted courteous forms of oral communication in conversing with the customer.
2. Speaks with a pleasant, modulated tone of voice.
3. Maintains socially accepted inter-body distance with the customer.
4. Affects pleasant facial expressions such as smiling, etc.
5. Uses positive or accepting hand and body movements.
6. Creates an overall impression of interest in the customer.

Salesmanship

Using written and oral communications, and demonstrations of products or services, increases the probability of customer purchase by the effective arrangement and presentation of information.

1. Communicates orally or in writing to the customer the specific characteristic(s) of the product or service.
2. Demonstrates the operation of the product or service, when necessary.
3. Communicates with the appropriate people to promote good will or receive technical advice about the product or service, when necessary.
4. Obtains and analyzes pertinent information concerning the customer's current situation and selects the appropriate products(s) or service(s) for the customer, when necessary.
5. Prepares forms and sales contracts.
6. Follows up and evaluates the service or product selected by the customer.
7. Displays product or service through window displays, advertising posters, catalogues, samples, when necessary.
8. Resolves problems or complaints concerning the product or service.

Safety Practices

Observes safety rules and regulations, uses mechanical guards and devices, and follows safety procedures.

1. Wears appropriate safety equipment and clothing.
2. Observes safety rules with regard to lifting, smoking restrictions, drinking, and drugs, etc.
3. Inspects to see if guards, stops, and safety switches, governors, grounds, etc., are in place or are in operating order before starting equipment and inspects to see that ventilation, lighting, etc., are appropriate.
4. Clears work area before starting work operations; checks to see that all securing devices are tight; checks clearances required.
5. Assumes correct body position while performing work operation(s); makes all adjustments only when machine is not operating; follows specified safety procedures for machine malfunction; uses only the tools and equipment which are appropriate for the work operation to be performed.
6. Clears waste from work area when operation is complete; inspects to be sure machine has stopped running before leaving machine unattended; returns tools, equipment, materials and work media to appropriate storage area.

7. Reports all injuries immediately; maintains a serious attitude toward work; and performs only those work operations for which trained.

Spatial Visualization

Given product specifications, constructs three-dimensional, sometimes dynamic concepts, of work media.

1. Translates product specifications into part requirements.
2. Using part requirements, visualizes individual parts.
3. Determines the time, place and sequence of operations of individual parts.
4. Visualizes spatial interrelations of parts.
5. Integrates parts into a three-dimensional concept.
6. Using a knowledge of physical principles, visualizes the relative motion and forces of the individual parts, when necessary.
7. Elaborates and develops the detail of individual parts and their interrelations.
8. Usually generates rough sketches, drawings or models to reflect design detail.

Visual Translation

Given a two dimensional representation of work media, converts this into a three-dimensional concept, changing drawing dimensions into scale dimensions.

1. Using spatial cues and knowledge of drawing conventions, integrates plane views into three-dimensional concept of work media.
2. Converts drawing dimensions into scale dimensions.
3. Develops and analyzes the pertinent details of the three-dimensional concept of work media.

Dynamic Translation

Given a static two or three-dimensional representation of work media, converts this into a three-dimensional dynamic concept expressing relative motion, force, and time.

1. Converts a two-dimensional representation of work media into a static three-dimensional concept by visual translation.
2. Determines the time, place, and sequence of operations of individual parts.
3. Visualizes spatial interrelations of parts.
4. Using a knowledge of physical principles, visualizes the relative motion and forces of the individual parts.
5. Develops and analyzes the pertinent details of the dynamic three-dimensional concept of work media.
6. Develops the proper values and/or conditions of the completed product.

Mechanical Trouble Shooting

Defines the malfunction(s); attempts to isolate the malfunctioning parts(s), subsystem(s) or system(s); adjusts, repairs, or replaces malfunctioning part(s); determines if malfunction(s) are corrected.

1. Obtains operator description of machine's malfunction(s).
2. Further clarifies malfunction(s) by questioning operator and/or by observation of machine in operation, if necessary.
3. Drawing upon experience and/or by using reference materials, attempts to isolate malfunctioning part(s) by examining parts, subsystems, and/or systems in accepted sequence (may require disassembly).
4. Performs a precision adjustment on malfunctioning part(s) when necessary; repairs by means of welding, soldering, cleaning, reboring, etc.; or replaces malfunctioning part(s) with new parts, and reassembles, when necessary.
5. Observes machine in operation to determine if malfunction(s) have been corrected.
6. If malfunction(s) still exist, returns to Step 3.

USE OF DIAGNOSTIC EQUIPMENT

Defines critical characteristics of parts of machines to be diagnosed; determines correct settings of controls; manipulates controls; connects parts or machine to diagnostic equipment; and obtains readings.

1. Takes parts or machine to diagnostic equipment or vice versa.

2. Determines critical characteristics of part(s) or machine to be diagnosed; e.g., model number, brand, etc.

3. Drawing upon experience and/or by using reference materials and in conjunction with the critical characteristics of part(s) or machine to be diagnosed, determines the correct control settings on diagnostic equipment, where necessary.

4. Manipulates controls to obtain correct settings of diagnostic equipment, where necessary.

5. Correctly connects part(s) or machine to diagnostic equipment.

6. Manipulates and/or operates part(s), machines, and/or diagnostic equipment during diagnosis, when necessary.

Use of Diagnostic Equipment 2

7. Reads indicators on diagnostic equipment.

8. Converts reading(s) from diagnostic equipment into other units where necessary.

APPENDIX C

APPENDIX C

Measuring

Uses the appropriate measuring instruments and units of measurement to determine the dimensions, quantity, degree, and/or capacity of work media.

1. Determines appropriate scale of measurement, unit of measurement, and level of precision. (For each scale of measurement used, list the usual unit of measure and the range of tolerances.)

Scale of Measure	Usual Unit of Measure	Tolerance
Linear	inches	.0001 - .01
Angular	minutes	1 - 30

2. Selects measuring instrument(s) possessing the appropriate scale of measurement, unit of measurement, and level of precision. (For each scale of measure, list appropriate measuring instruments, unit of measurement, and level of precision.)

Scale	Measuring of Instrument	Unit of Measure	Precision
Linear			
	Rule (spring, hooked, narrow, flexible)	inches	.01
	Dial Indicator	inches	.001

3. Operates measuring instrument(s). (For each type of measuring instrument, give a general operating procedure and specific examples of measuring instruments.)

Diametric Measurements (caliper-rule, micrometer caliper, vernier calipers, dividers-vernier calipers). Set the opposing contact points of the measuring instrument on a diameter of the object to be measured.

4. Determines dimensions, quantity, degree, and/or capacity of work media. (Give a general procedure for reading off the measurement for each type of measuring instrument and specific examples of measuring instruments.)

Single Scale (rules, height gage, caliper-rule, bevel protractor, gage blocks, surface gage-scriber-bevel protractor). The measurement is read off the measuring instrument at the end point of the work media which does not fall at the zero measure on the measuring instrument.

APPENDIX D

APPENDIX D

MEASURING (1)* Machine Trades

	Scale of Measure	Usual Unit of Measure	Tolerance
1)	Linear	inches	.00001 - .01
2)	Angular	minutes	1 - 30
3)	Hardness	inches	.001 - .01
4)	Feed	Revolutions per minute	0.5 - 1.0
5)	Speed	Feet per minute	
6)	Thread	Threads per inch	.0001 - .0015
7)	Taper	Taper per inch	.00001 - .0001
8)	Surface quality (flatness)	inches	.00001 - .

*Determines appropriate scale of measurment, unit of measurement, and level of precision.

MEASURING (2)* Machine Trades

Scale	Measuring Instrument	Unit of Measure	Precision
1) Linear:	Rule (spring, hooked, narrow, flexible)	inches	.01
	Caliper-rule (spring joint, firm joint, transfer, hermo-phrodite)	inches	.01
	Surface gage, scriber, bevel protractor	inches	.01
	Wiggler-rule	inches	.01
	Micrometer Caliper (outside (1 - 12 in.), inside, screw thread, depth)	inches	.001
	Vernier Caliper (gear tooth)	inches	.001
	Dial Indicator	inches	.001
	Divider-Vernier Caliper	inches	.001
	Trammels-Vernier Caliper	inches	.001
	Heights Gage	inches	.001
	Twist Drill Gage	inches	.001
	Planer Gage-micrometer caliper	inches	.001
	Gage Blocks	inches	.00001

*Selects measuring instruments(s) possessing the appropriate scale of measurement, unit of measurment, and level of precision.

MEASURING (2)* Continued

Scale	Measuring Instrument	Unit of Measure	Precision
2) Angular:			
	Drill Point Gage	degrees	1
	Steel Square	minutes	
	Bevel Protractor	minutes	30
	Vernier Bevel Protractor	minutes	5
	Gage Blocks and Sine Bar	minutes	1
	Steel square and dial indicator	inches	.001
3) Rockwell Hardness:			
	Rockwell Hardness Tester	inches	.001
4) Feed:	Speed Indicator	revolutions per minute	
5) Speed:			
6) Thread:	Plug Thread Gage	threads per inch	
	Ring Thread Gage	threads per inch	
	Roller Thread Gage	threads per inch	
	Thread Pitch Gage (Screw Pitch Gage)	inches	
7) Taper:	Taper Ring Gage	taper per inch	
	Taper Plug Gage	taper per inch	
	Gage Blocks and Sine Bar	taper per inch	.0001

MEAURING (2)* Continued

Scale	Measuring Instrument	Unit of Measure	Precision
8) Surface Quality (flatness):	Steel Rule		
	Level	inches	.01
	Dial Indicator	inches	.0001
	Profilometer	inches	.000001
	Brush Surface Analyzer	inches	.000001
	Comparoscope	inches	.0000001

MEASURING (3)* Machine Trades

1) Linear measurements on flat surfaces (rules, height gages, gage blocks, trammels, dividers, planer gage, surface gage - scriber-bevel protractor)

   The end point of the measuring instrument is placed in a straight line with one end point of the work media, and the body of the measuring instrument is placed parallel to the measure of interest.

2) Diametric measurements (caliper-rule, micrometer caliper, vernier caliper, dividers-vernier calipers, drill gage, trammels-vernier calipers)

   Set the opposing contact points of the measuring instrument on a diameter of the object to be measured.

3) Angular measurements (bevel protractor, vernier bevel protractor, gage blocks and sine bar, steel square, drill point gage)

   Set the arms of the measuring instrument so that each arm touches one side of the angle to be measured.

4) Tolerance measurements (plug thread gage, ring thread gage, roller thread gage, taper ring gage, taper plug gage, thread pitch gage)

   Fit the object to be measured into both the "go" section and "no-go" section of the gage.

5) Flatness measurements (steel rule, dial indicator, level, profilometer, brush surface analyzer)

   Move the measuring instrument across the surface to be measured.

6) Density measurements (Rockwell Hardness Tester)

   Various weighted loads are forced into the metal surface.

7) Feed-Speed measurements (Speed Indicator)

---

*Operates measuring instruments(s).

MEASURING (4)* Machine Trades

1) Single Scale (rules, height gage, caliper-rule, bevel protractor, gage blocks, surface gage-scriber-bevel protractor)

The measurement is read off measuring instrument at the end point of the work media which does not fall at the zero measure on the measuring instrument.

2) Vernier or Multiple Scale (vernier caliper, micrometer caliper, vernier bevel protractor, gage blocks and sine bar, divider and vernier caliper, trammels and vernier caliper, planer gage-micrometer caliper)

The measurement is read off two or more scales. The number of whole units is read off the main scale. Finer readings are taken from the secondary scales and are added to the original reading.

3) Dials and Indicators (Dial Indicator, Speed Indicator, Level)

The measurement is read off the measuring instrument at the point to which the pointer is directed.

4) Go-No-go Gages (twist drill gage, drill point gage, plug thread gage, taper ring gage, taper plug gage, thread pitch gage)

The measurement is made by determining whether the object to be measured fits either the "go" or "no-go" section of the gage. An acceptable piece of work media will fit the "go" section of the gage, but not fit the "no-go" section of the gage.

*Determines dimensions, quantity, degree, and/or capacity of work media.